

Greenhouse Designs & Construction



7 Most Common Greenhouse Designs



1. The ***lean-to greenhouse*** shares a wall with a building and relies on the building structure to provide some support for the greenhouse roof.

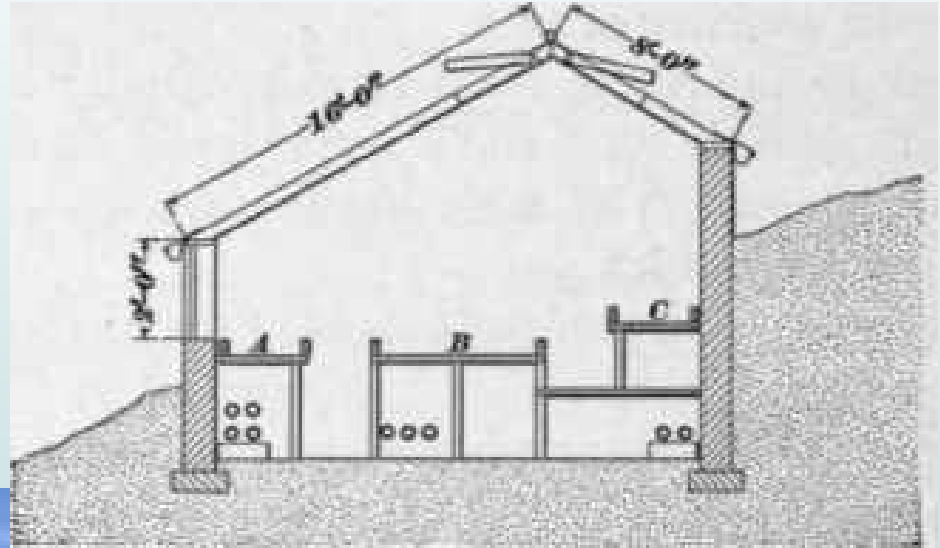


2. ***Even-span greenhouse*** structures are single houses that have roofs with an even pitch and an even width.

- A common even-span greenhouse that uses arching pipes for the framework is called a ***hoophouse***.



3. ***Uneven-span greenhouses*** have unequal pitches and widths.



4. ***Ridge-and-furrow greenhouse*** structures consist of a number of greenhouses connected along the length of the house.

- The shared interior walls reduce energy costs and allow for large interior spaces.
- Ridge-and-furrow greenhouses are best oriented north and south to reduce permanent shadows on the crops, which are created by the gutters.



5. ***Retractable-roof greenhouse*** designs allow the roof to be opened and closed.

- When open, they provide plants with increased light levels and fresh air.



6. ***Shadehouses*** are structures used to protect plants from wind, heat, and light intensity.

- Synthetic shade cloth is the most widely used covering material.
- It can be purchased with varying degrees of shade, depending on the grower's needs.

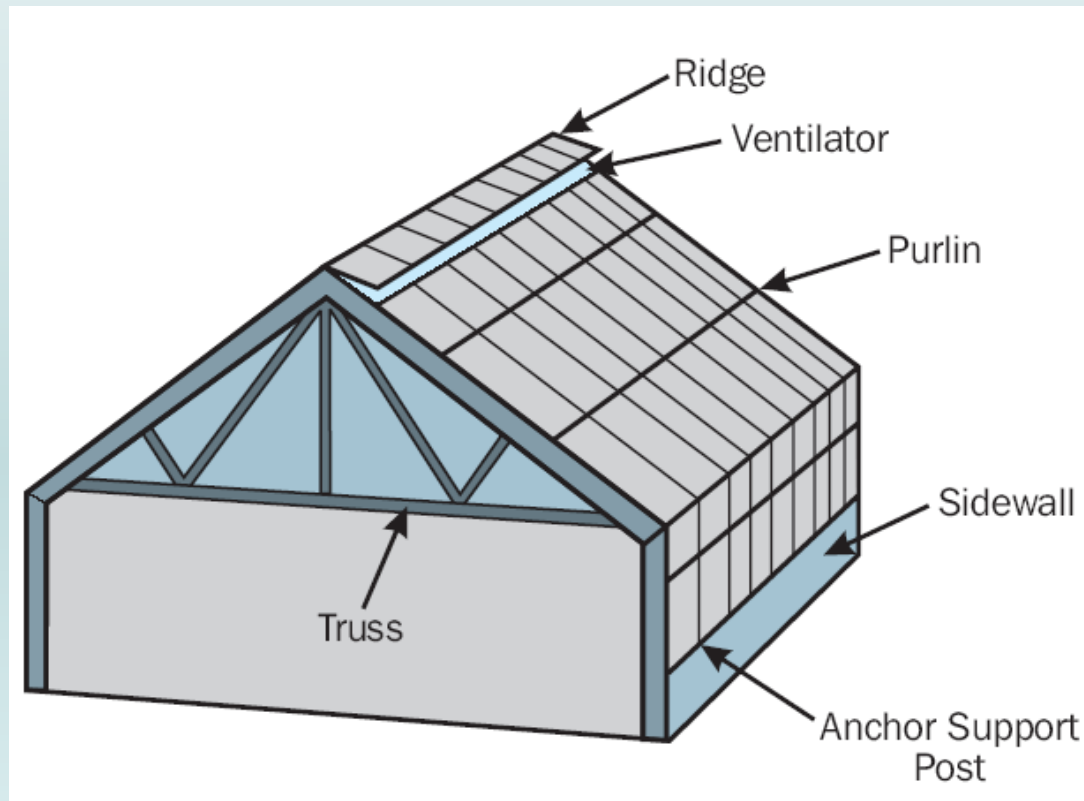


7. ***Cold frames:*** are structures used to protect plants from wind, cold, and light intensity.



Greenhouse frameworks?

- The ***greenhouse framework*** supports the greenhouse covering material.



- The framework should be strong, yet allow the maximum amount of light to reach the plants.
- It is best if the framework requires little maintenance.
- In northern latitudes it is important that the framework be strong enough to withstand heavy snow loads.

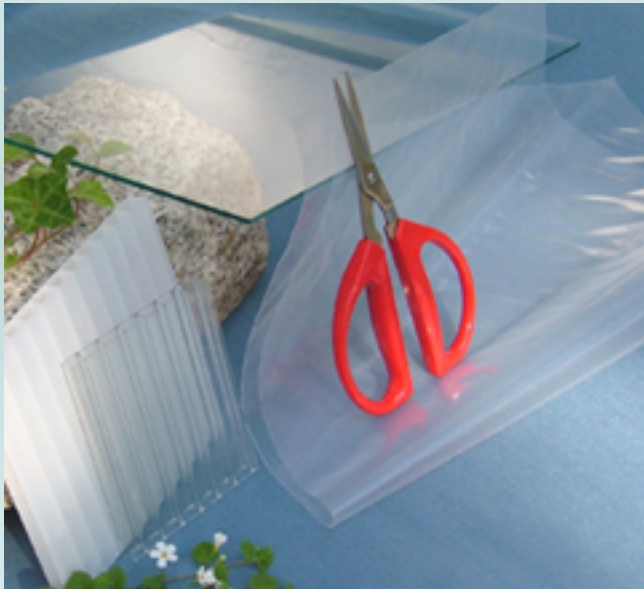


- Aluminum and aluminum/steel combination frameworks are popular because they are long lasting and are considered to be low maintenance.
- Other framework materials include wood, galvanized steel, and angle iron.

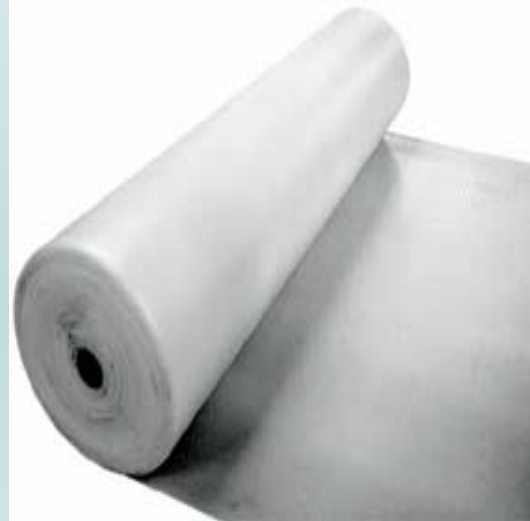


Greenhouse glazing?

- The covering of the greenhouse is referred to as the ***glazing***.
- Considerations in choosing a glazing material include durability, light transmission, cost, and affects on heating costs.



- Flexible sheets of ***polyethylene*** are stretched over the greenhouse framework; it is not very durable and must be replaced every one to three years depending on the thickness used.
 - Polyethylene is the least expensive covering material.

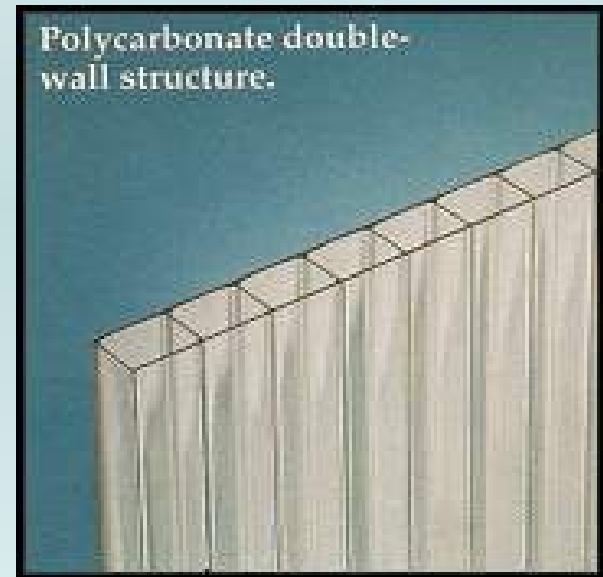


- ***Structured sheets***, including polycarbonate, acrylic, and fiberglass materials, have grown in popularity.
 - Sheets made with double walls offer good insulation.



Polycarbonate structured sheets are most widely used because they have good light transmission, they resist hail damage, and they are easy to work with.

- Polycarbonate is much stronger than glass, but it is lighter in weight.
- In addition, polycarbonate has good insulation properties and is flame retardant.



Acrylic structured sheets have high light transmission, but they cost more than polycarbonate sheets, are prone to hail damage, and are less flexible.



Fiberglass has dropped in popularity.

- It discolours after 7 to 10 years and provides poor insulation.
- Fiberglass loses light transmission as it wears out, and it becomes extremely flammable as it ages and the fibers become exposed.



- ***Glass*** is considered to be the best material for crop production.
 - It has the highest light transmission.
 - The fact that it is very long lasting can make it less costly than other glazing materials in the long run.
 - Tempered glass is stronger than regular glass.
 - Tempered glass may still break during hailstorms, and it has a high initial cost.



Headhouse

- Many of the tasks that support the production of greenhouse crops take place in a structure attached to the greenhouse known as a ***headhouse***.
- The headhouse might be used as a storage area, a potting area, an office, and/or a shipping area.



What are greenhouse bench options?

- The greenhouse ***bench*** is the structure that holds the plants above the ground.
- Materials used for benches include expanded galvanized steel, aluminum, plastic, and rot-resistant wood.
- Expanded galvanized steel provides good air circulation and allows water to drain from pots.

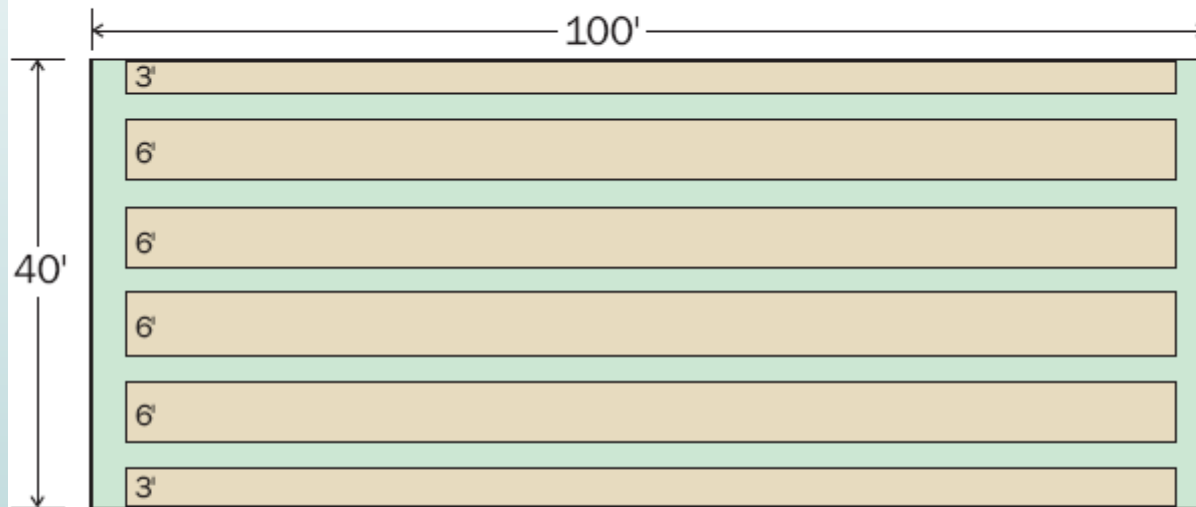


- Benches should be narrow enough for workers to reach for plants and to provide care.
- Benches are arranged in the greenhouse with aisle space and growing space in mind.
- Common layouts include conventional arrangements, peninsular arrangements, and movable benches.



What are greenhouse bench options?

CONVENTIONAL BENCH LAYOUT



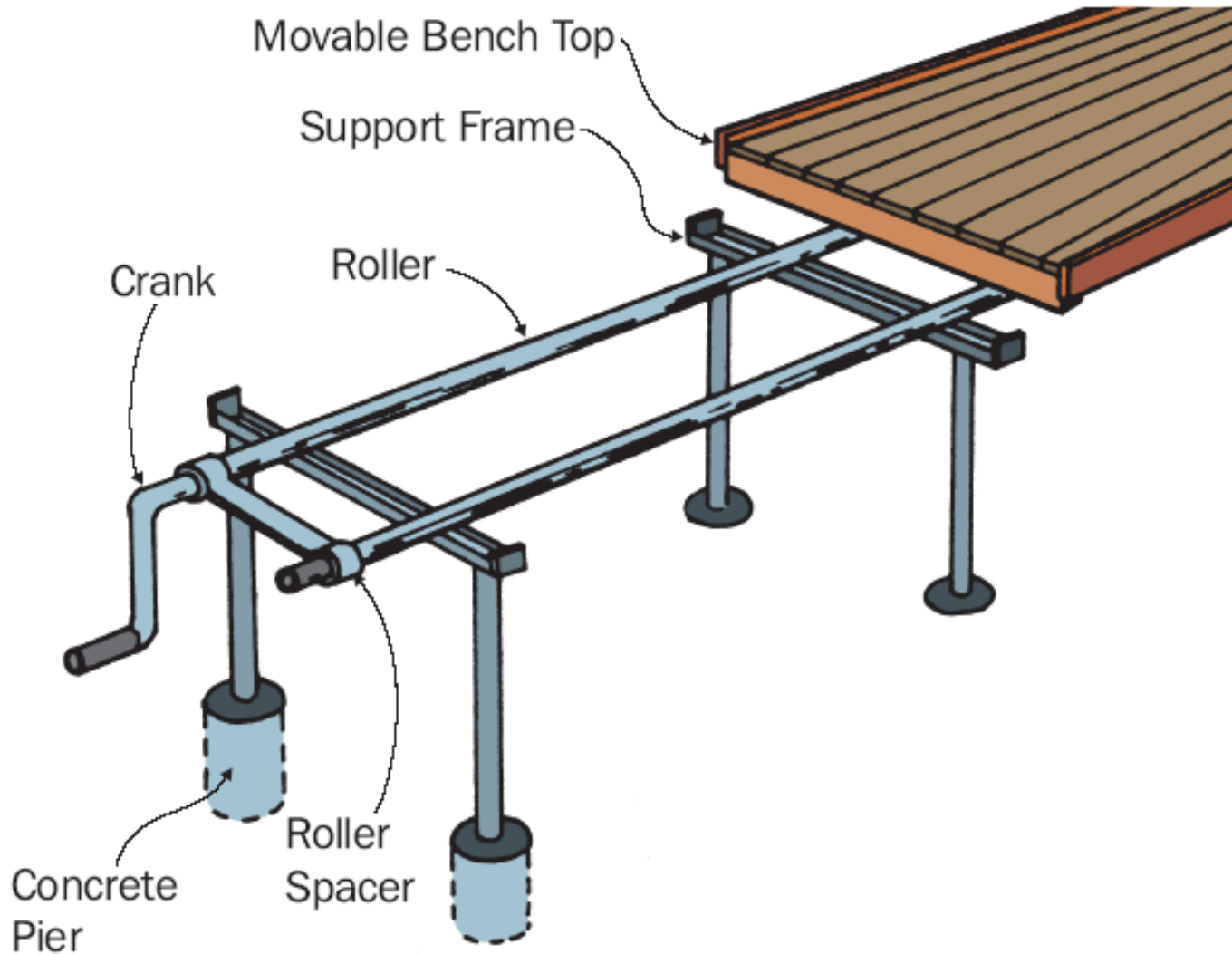
Floor Plan

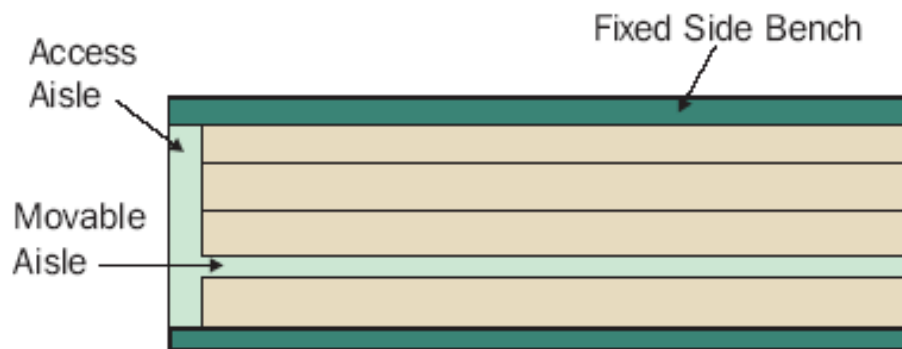
Ground Area 4000 sq ft

Bench Area 2820 sq ft

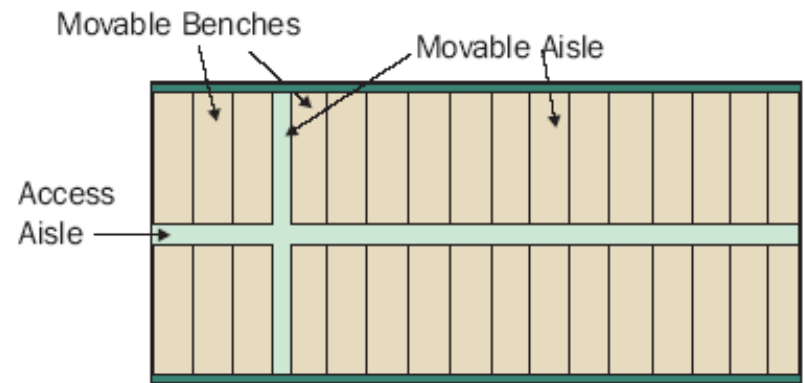
Aisle Area 1180 sq ft

PARTS OF A MOVABLE BENCH

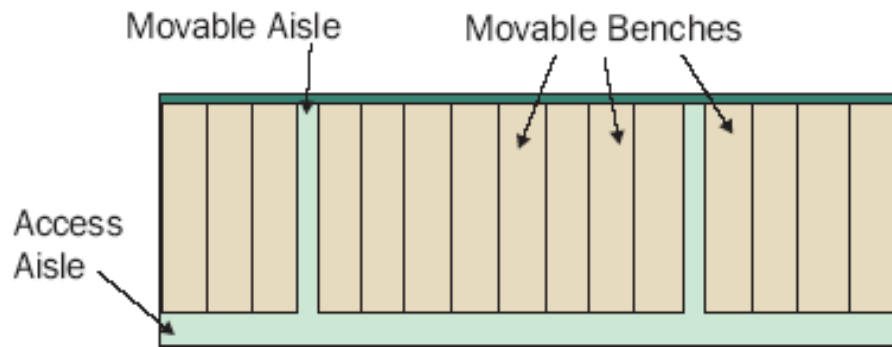




LENGTHWISE BENCHES with END ACCESS AISLE



CROSS BENCHES with CENTRAL ACCESS AISLE



CROSS BENCHES with SIDE ACCESS AISLE



Greenhouse construction



Post layout



- The string will be 7" above the ground and the posts will be driven until the proper drill hole is at the string.

Spacing and driving posts



Level the two lines of posts



- Use a line level or laser to level the frame left to right so you have a level end wall. The frame can slope end to end over the length.

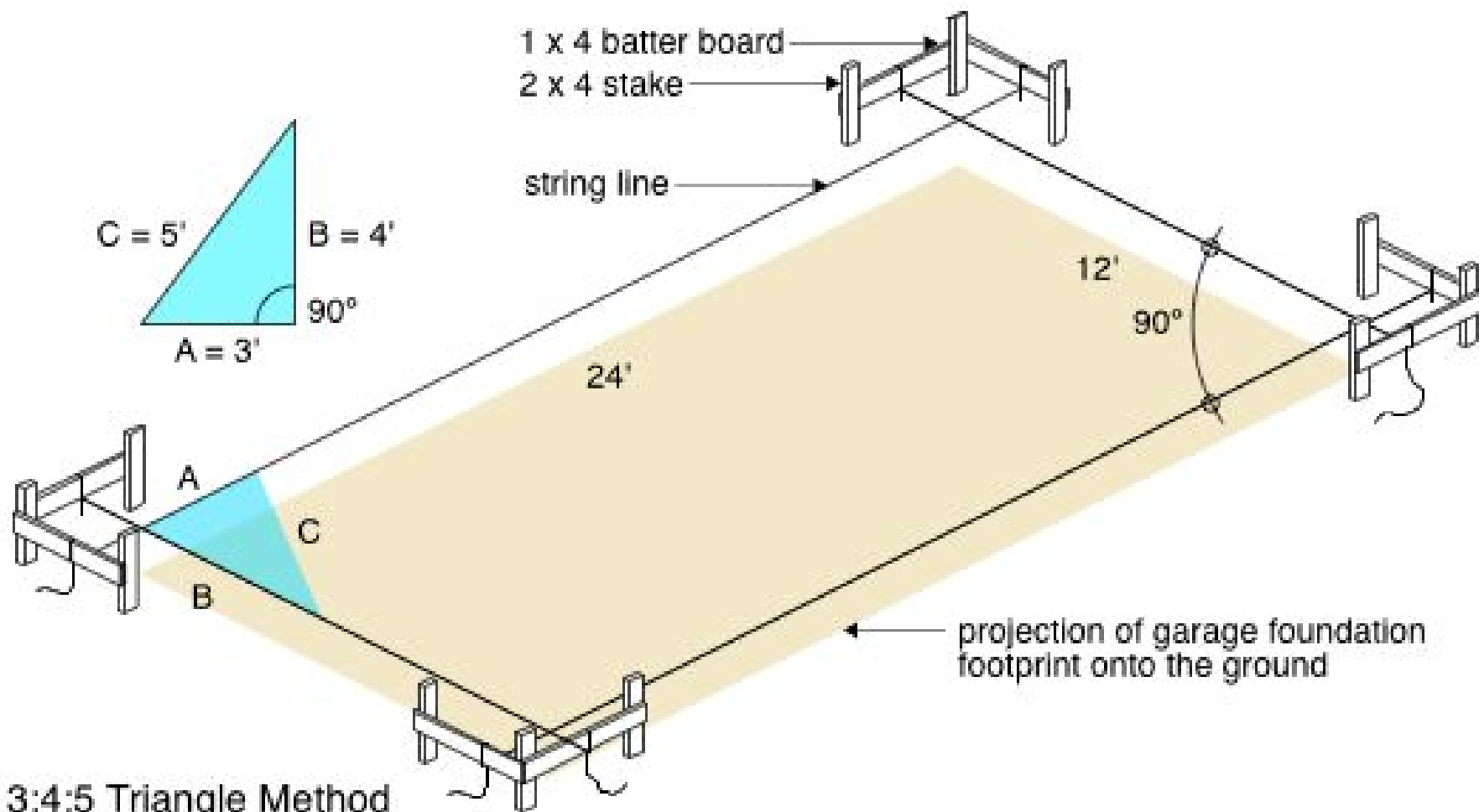
Squaring the greenhouse



Squaring the greenhouse



- Check your measurements to make sure your frame is square before you pound all the posts.



Assemble the bows



- The three pieces of the bow are assembled on the ground, and then erected as a unit.



- A pair of vise grips or clamp is attached to the bow at the black mark. When the bow is lowered into the post the clamp will stop the bow at the proper depth.

Finish erecting the bows





Installing purlins



Purlin joints



Install remaining purlins



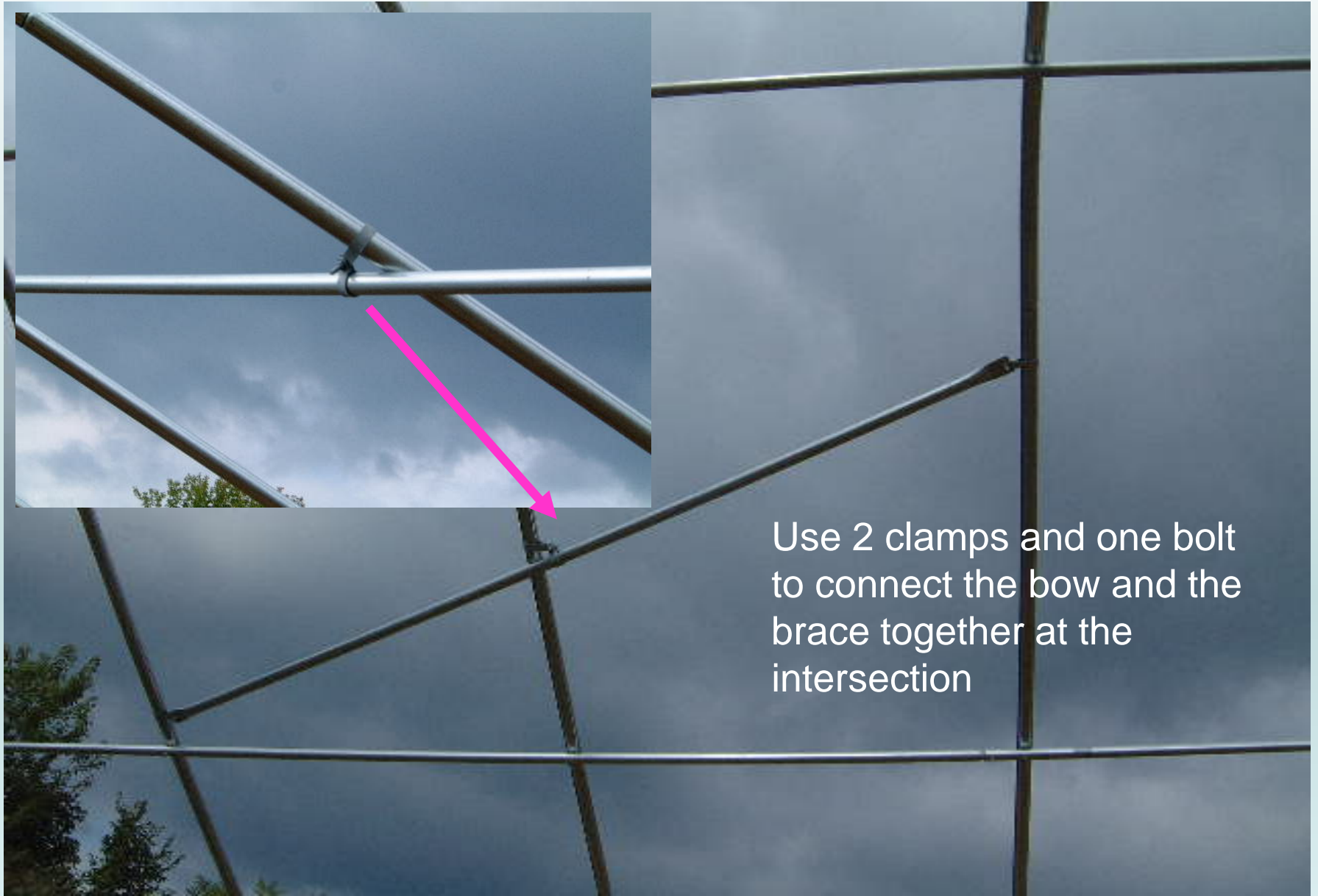
- The remaining purlins are installed from bottom to top. Always install the ridge pole last.

Corner brace installation



Clamp the lower end of a corner brace to the second bow using a long clamp, then pivot the corner brace so the other end can be clamped to the fourth bow with another long clamp.

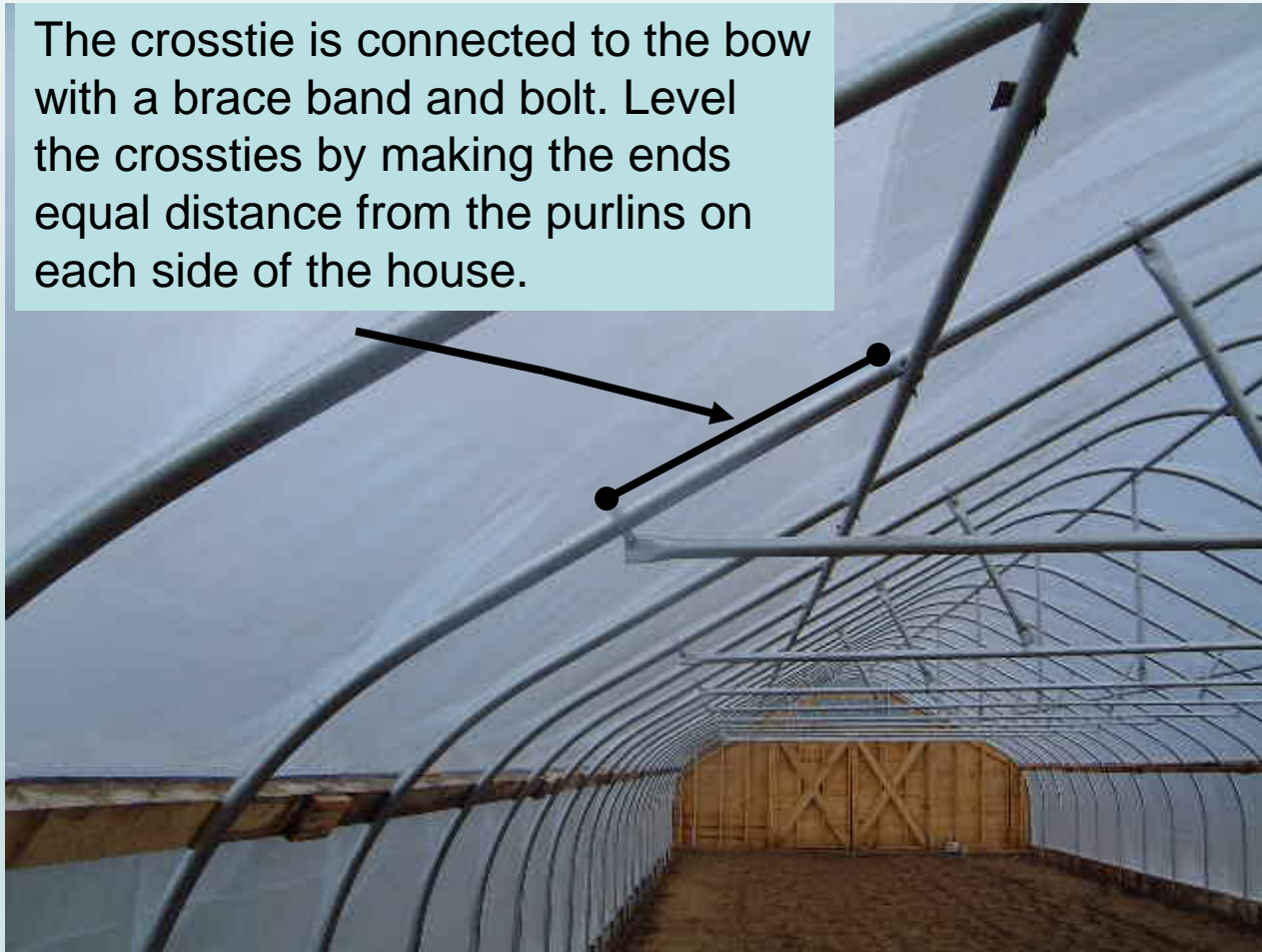
Finishing the corner braces



Use 2 clamps and one bolt to connect the bow and the brace together at the intersection

Crossties (if you have them)

The crosstie is connected to the bow with a brace band and bolt. Level the crossties by making the ends equal distance from the purlins on each side of the house.

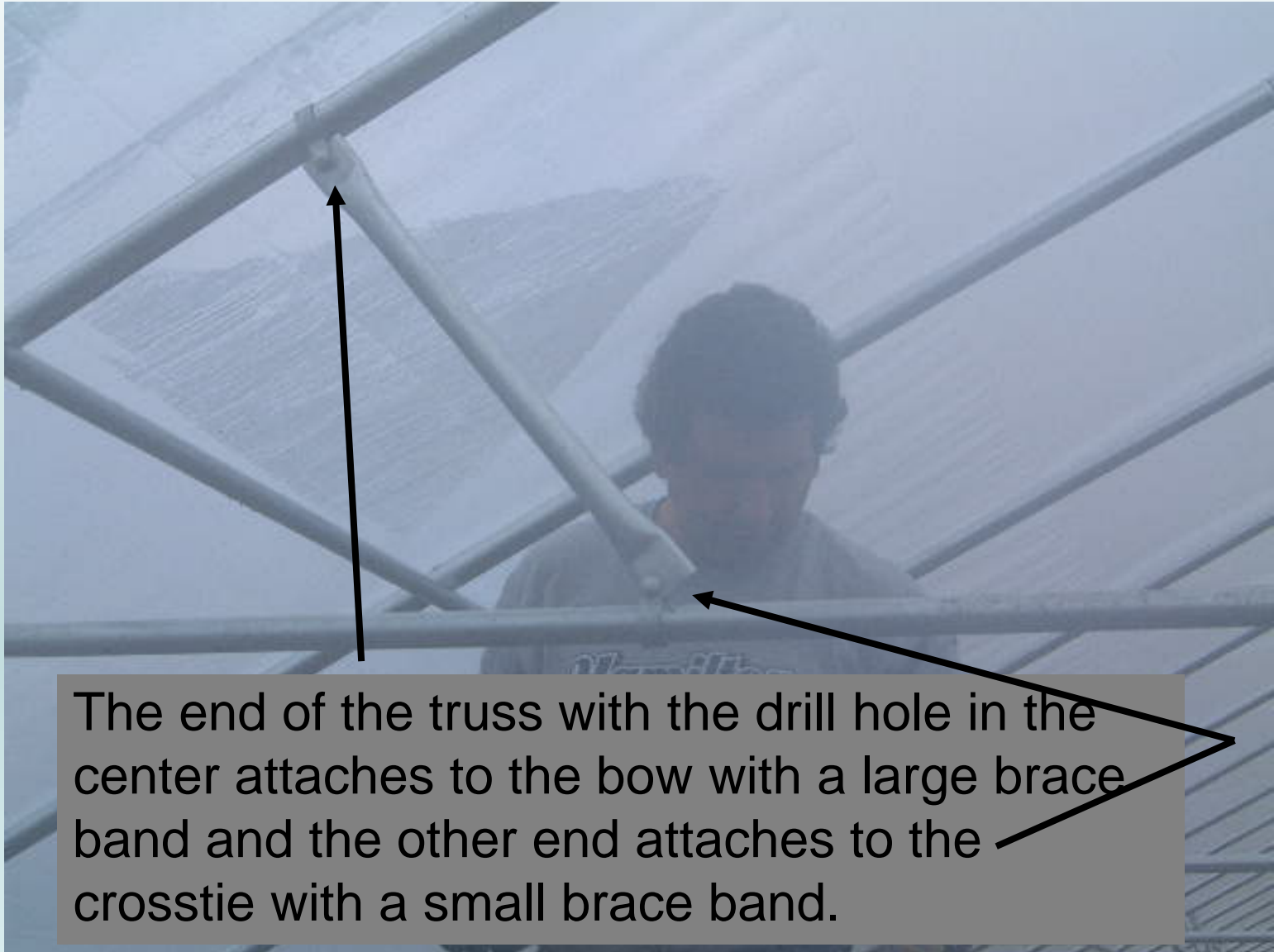


Crosstie and drops



Connect the drop to the crosstie using two small clamps. One attached to the ridge purlin and the other around the crosstie.

Adding the trusses to the crossties



The end of the truss with the drill hole in the center attaches to the bow with a large brace band and the other end attaches to the crosstie with a small brace band.

Baseboard

Mark the post so the baseboard is about 2" into the soil and the top of the board is straight the length of the house.



Option* Dig the soil out of the way so the top of the board will line up with the marks on the posts.

More baseboard



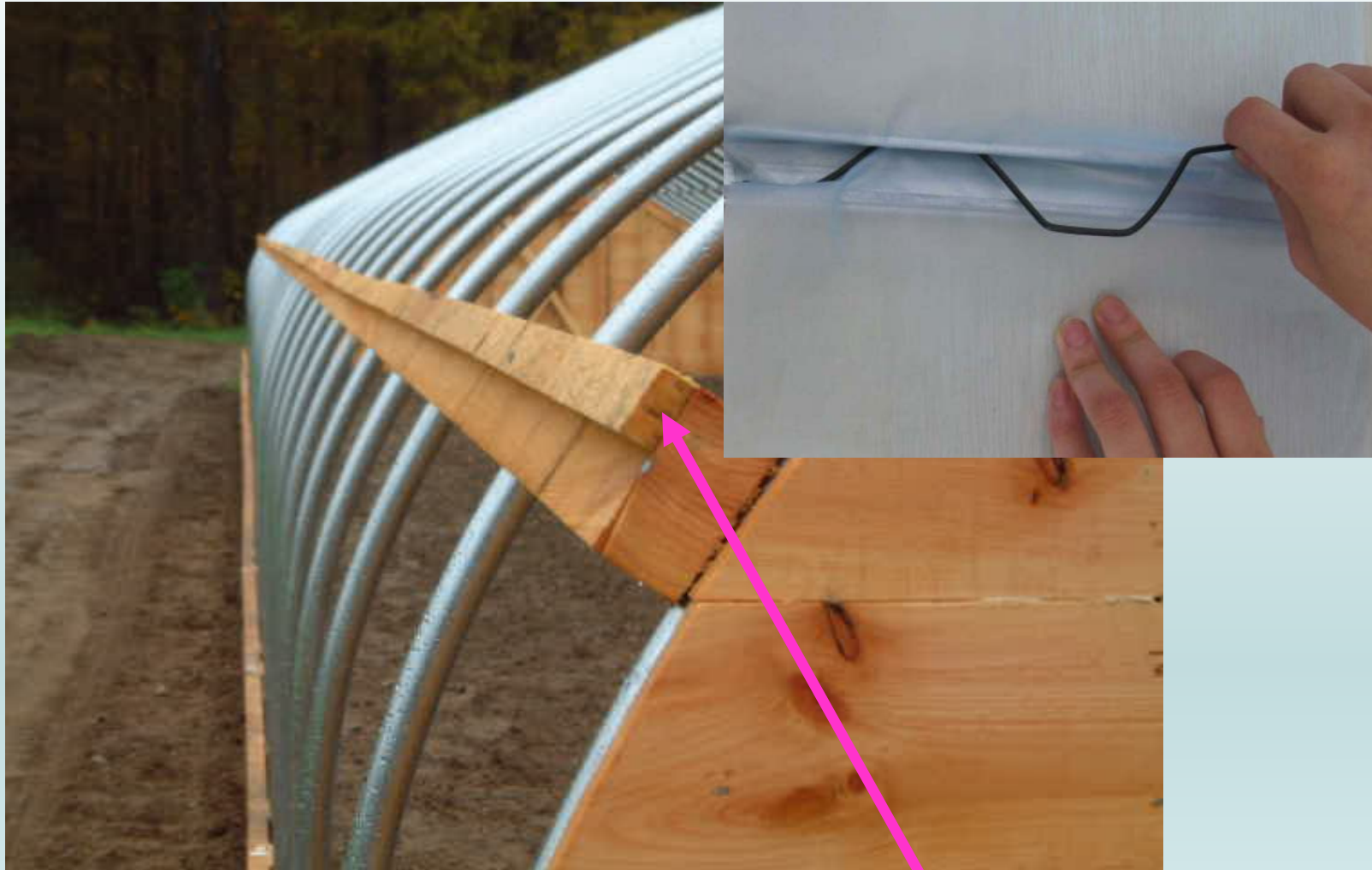
Use a second layer or one wide plank. Connect the joints with pieces of board.



Hip board for roll-up sides



Hip board and attaching poly



This piece of wood helps with snow and rain shedding.

Starting the end walls

Place a sill along the ground from side to side. Use banding to attach the sill to the bow and baseboard. Toenail the studs to the sill.



Metal banding to attach studs



Attach the banding with one screw on the outside of the stud, then wrap the banding over the bow and attach the band to the top of the stud.

Finish the end wall



You may use any material to finish the ends. Poly, clear structured sheets, boards, or plywood.

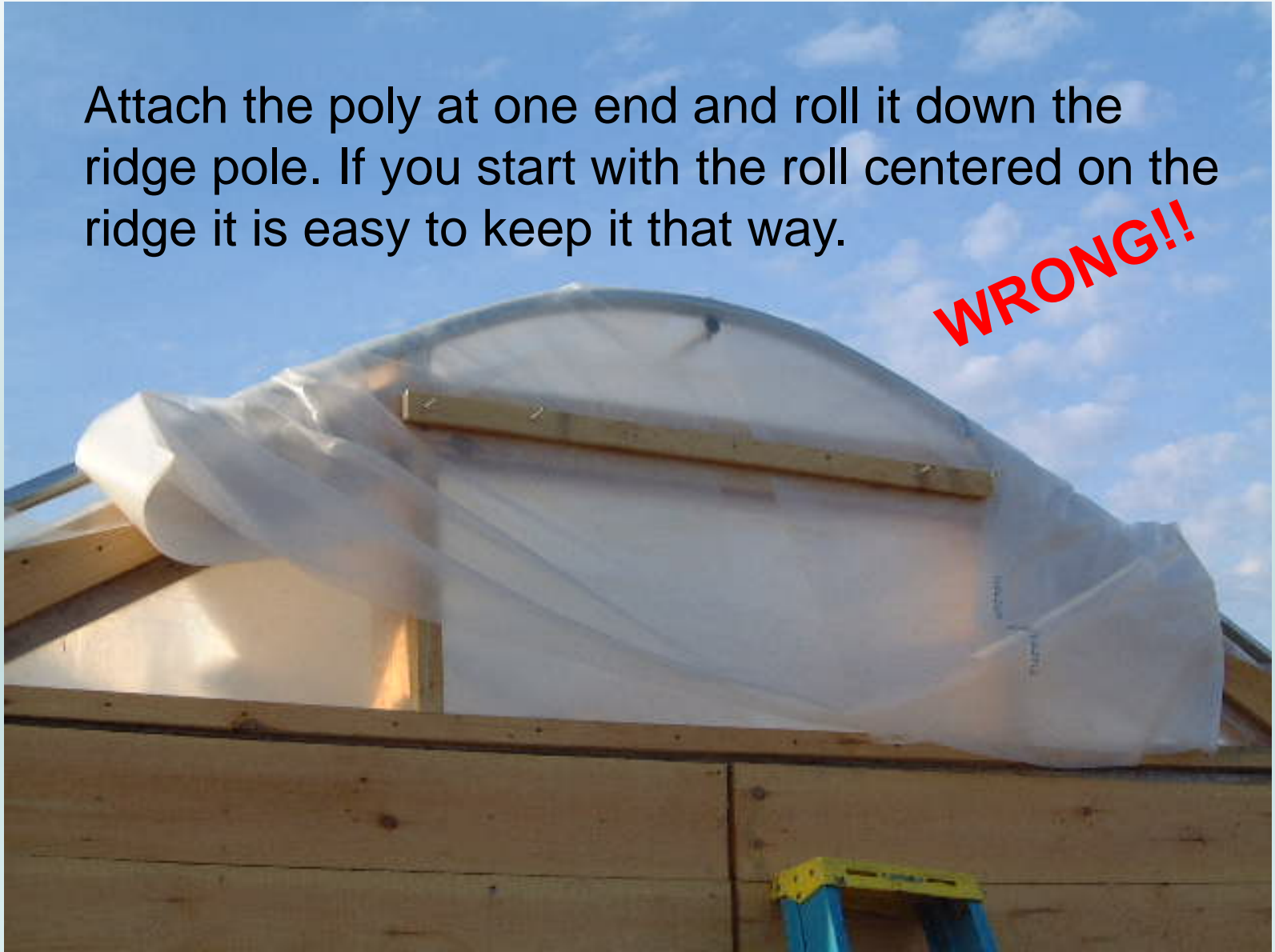
How about doors?



Ready for the poly

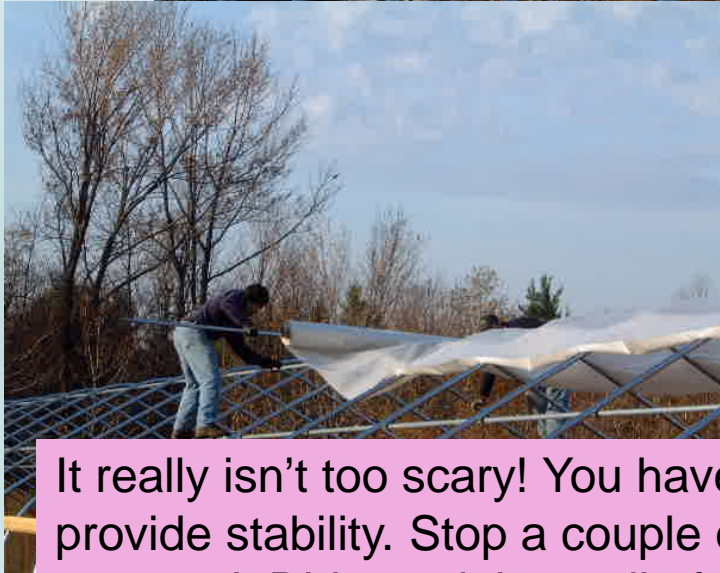
Attach the poly at one end and roll it down the ridge pole. If you start with the roll centered on the ridge it is easy to keep it that way.

WRONG!!



Here we go!

WRONG!!

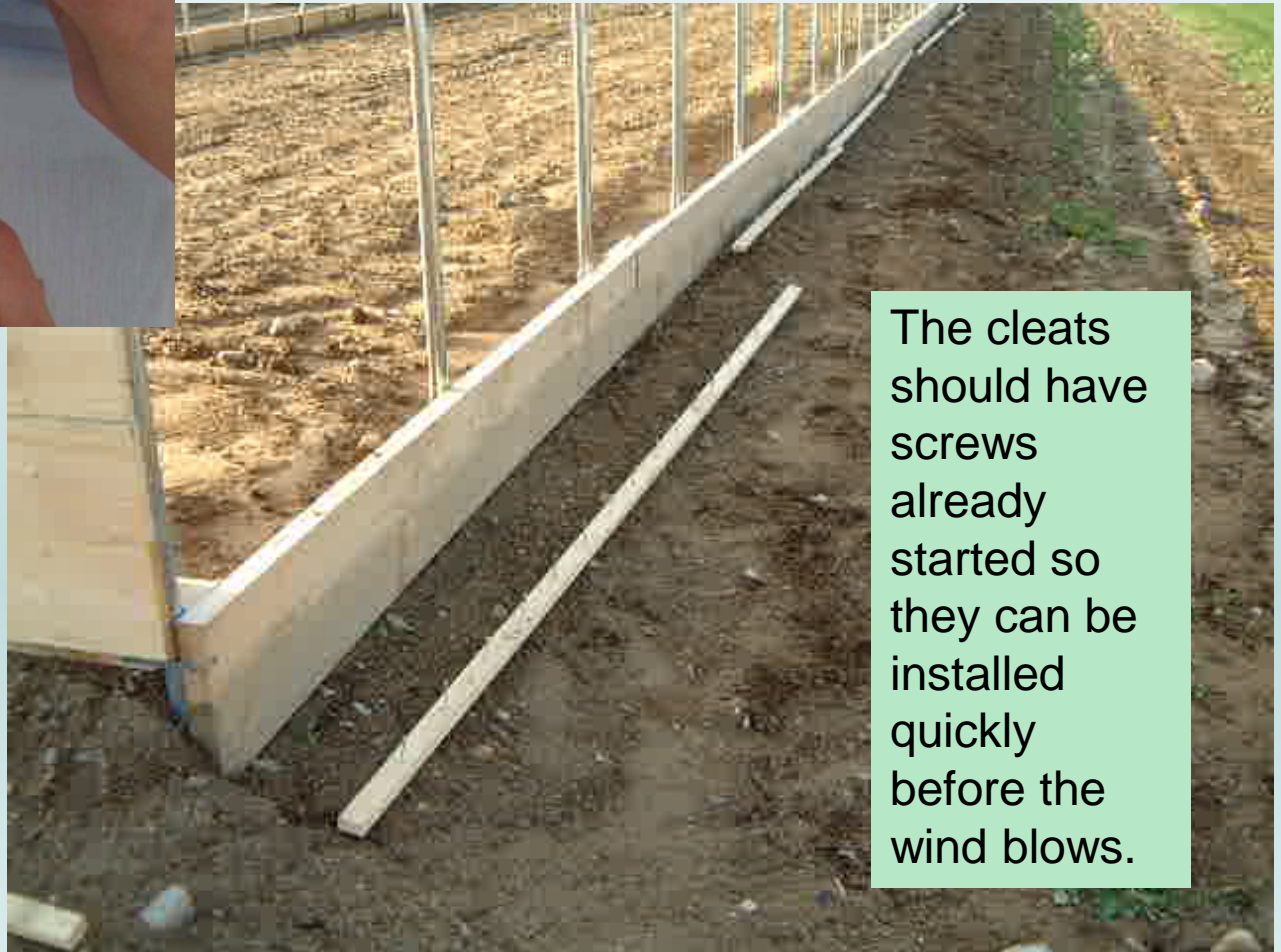
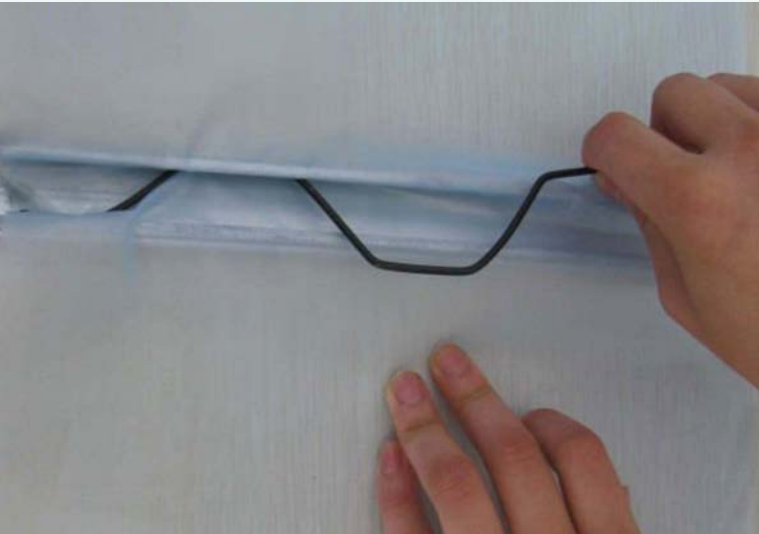


It really isn't too scary! You have the roll, the long pipe and your most trusted to provide stability. Stop a couple of times to pull the roll tight and make sure it is centered. Did you tighten all of the bolts?





Cleats ready to attach



The cleats should have screws already started so they can be installed quickly before the wind blows.

Spread out the poly



The poly should be pulled straight, square, and comfortably snug.

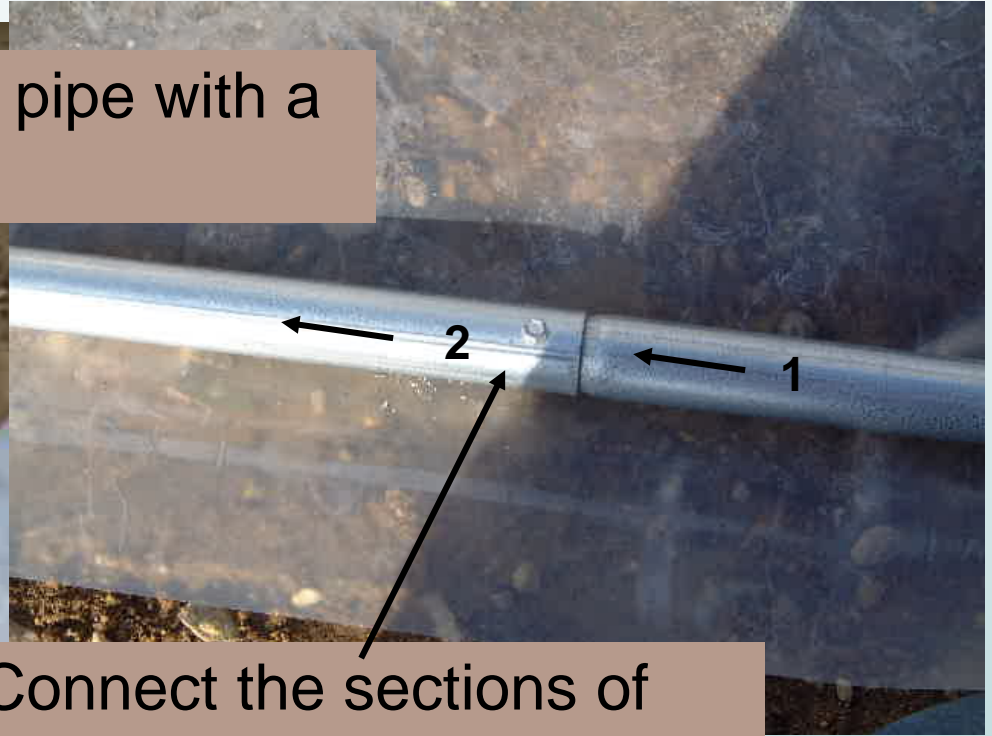
Attaching the strapping





Roll up side installation

Attach the handle to the roll up pipe with a 2" bolt and nut.



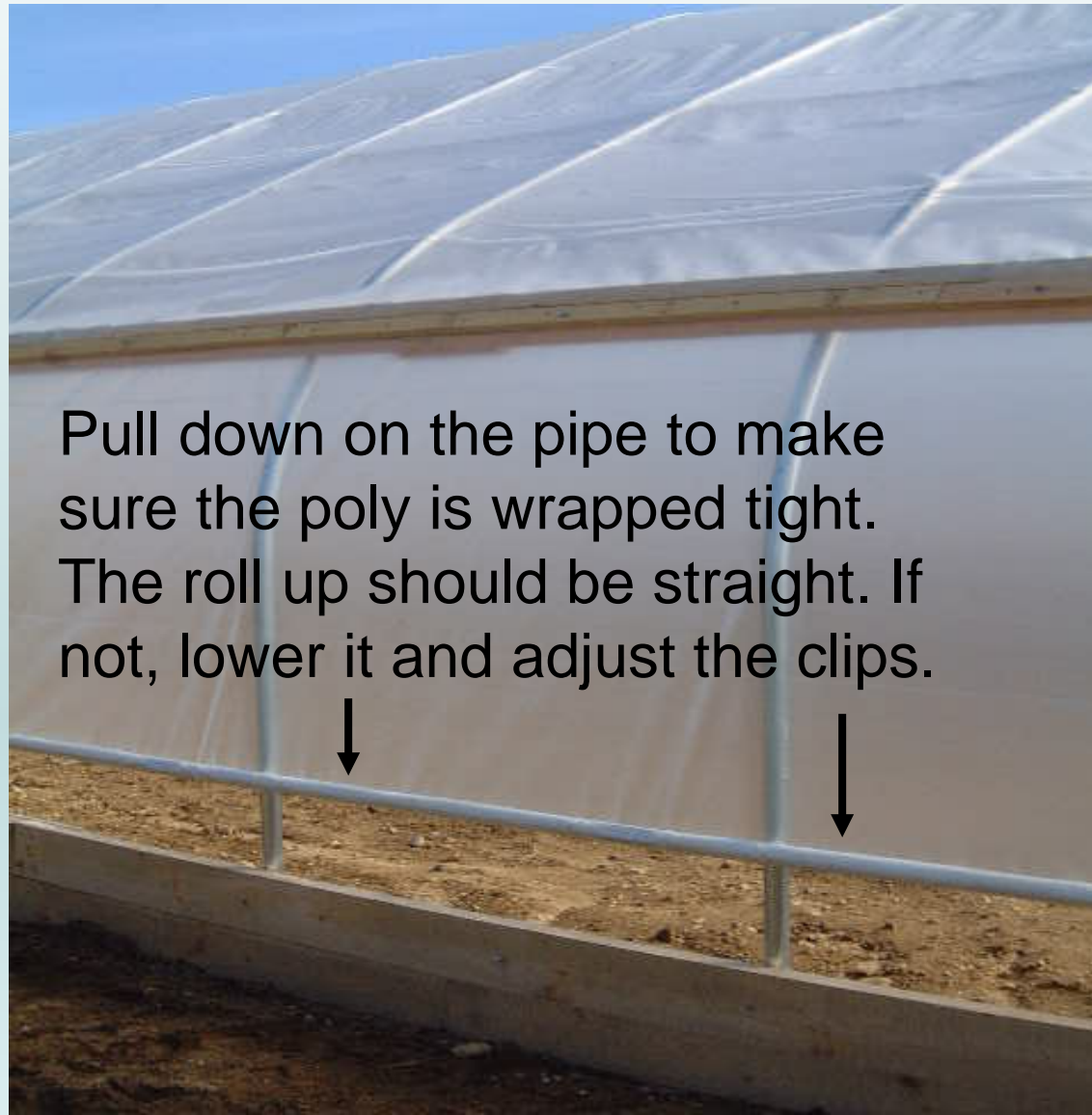
Connect the sections of pipe with the #12x3/4" Tek screws. Keep them in numerical order.

Attach the poly to the roll up pipe

Roll one wrap of poly around the pipe and put a clip onto the pipe. Be careful to keep the poly straight as you proceed the length of the house. The roll up will be perfect!



Make sure roll up is straight



Drill holes for bolts or attach lag eyes



Attach the bolts or eyes about midway between two bows. The bottom bolt will be about 3" below the top of the baseboard and the top bolt through the poly cleat. The ropes will be located every other bow, starting at the end bow.

Attaching the ropes

Rope attached to the hip board bolt



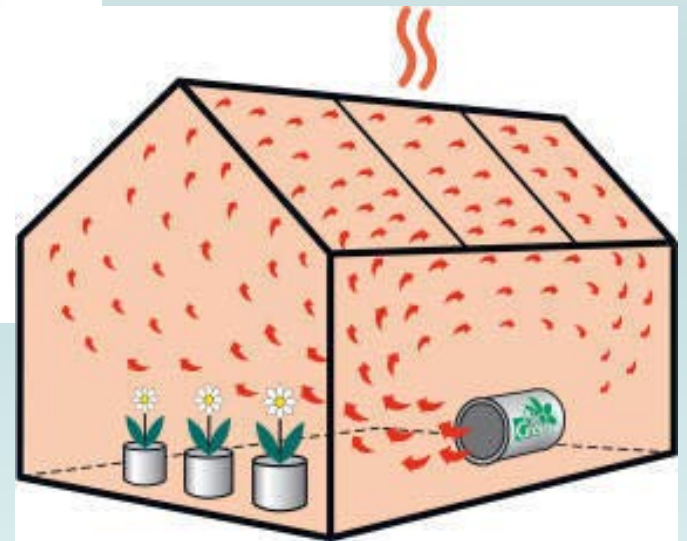
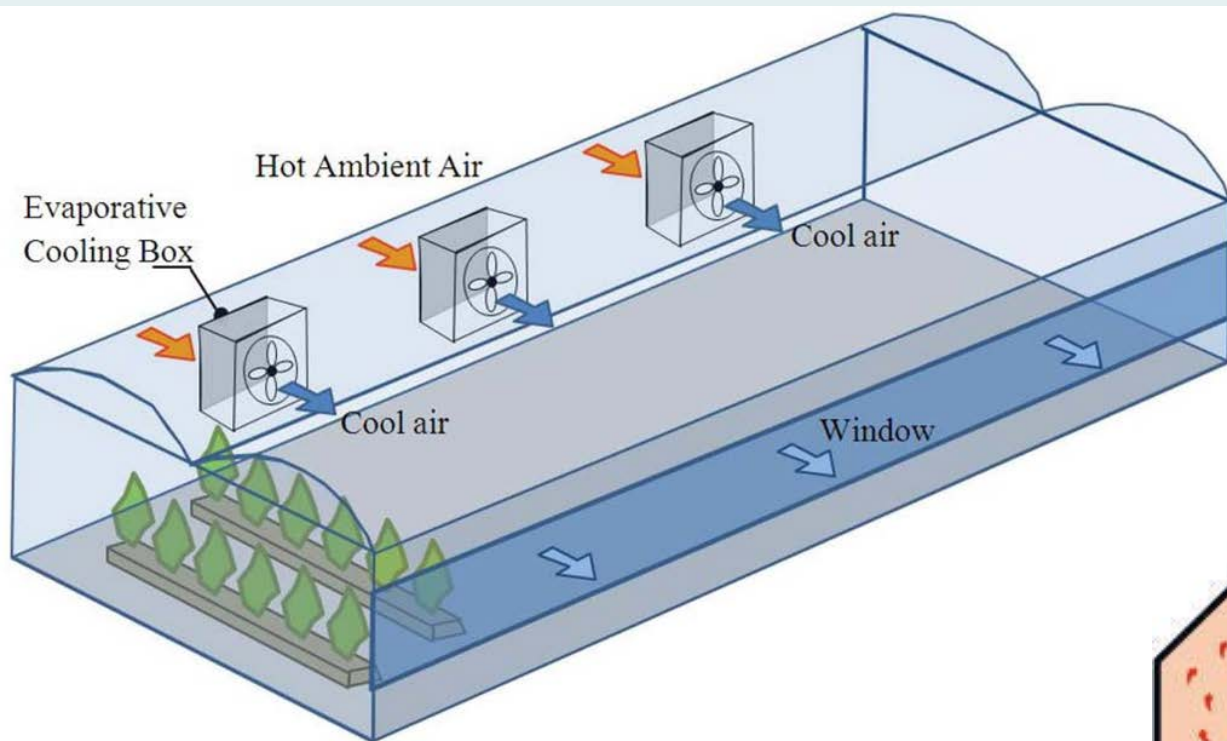
and to the baseboard



...and we're finished!



Greenhouse Cooling & Heating Concepts



Too HOT!!



- Loss of stem strength
- Reduction of flower size
- Delay of flowering
- Bud abortion



Passive Cooling







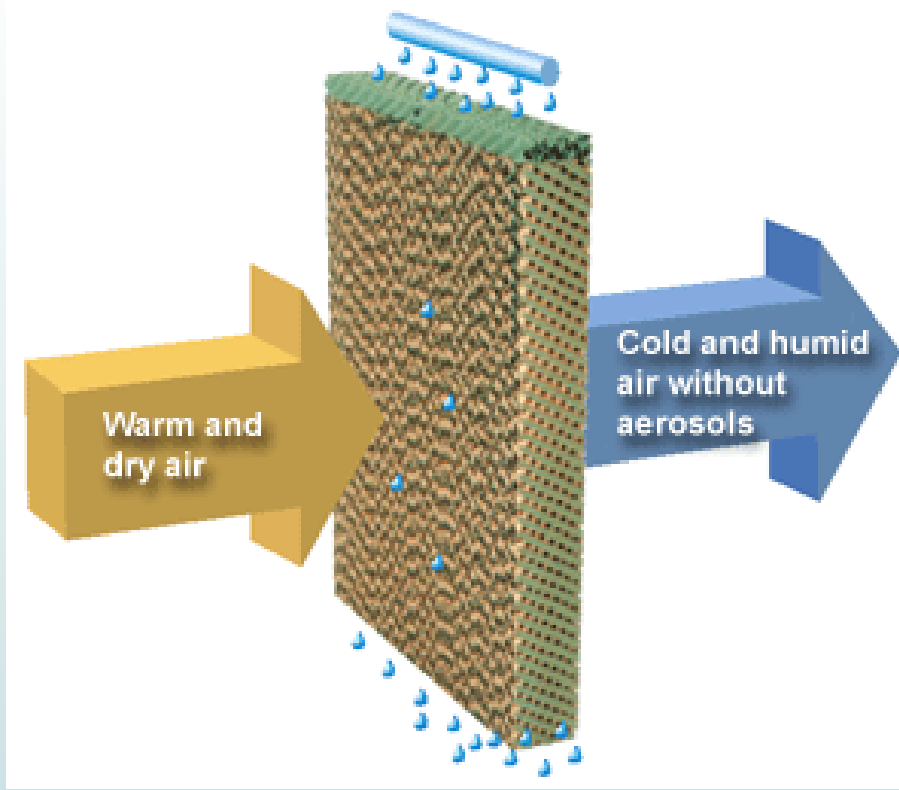


Active Cooling

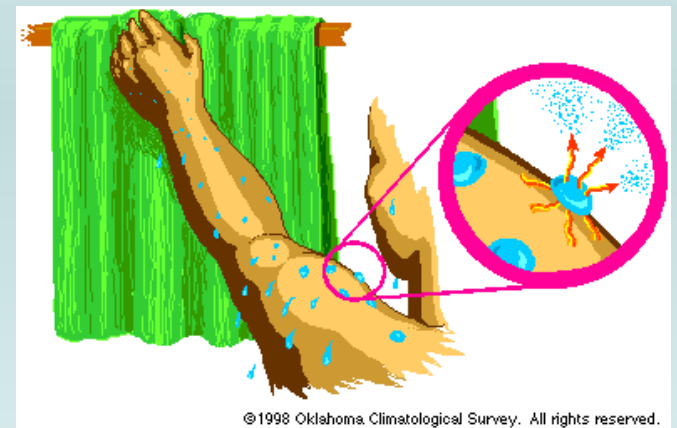








<http://www.munters.com/home.nsf/FS1?ReadForm&content=/products.nsf/ByKey/OHAA-55GSWH>



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<http://okfirst.ocs.ou.edu/train/meteorology/HeatTransfer.html>



Exhaust Fans





Fog Cooling



HAV (Horizontal Area Fans)





Too COLD!!



Heating Basics

- You must add heat at the rate it is lost
- Heat is lost by:
CONDUCTION, Infiltration,
and Radiation



Glazing Heat Loss

- Worst – single layer of polyethylene film or single layer of glass
- Best – 3 layer polycarbonate panels
- Double Layer of Poly with dead air space brings the heat loss down to .70 Units



Types of Heating Systems

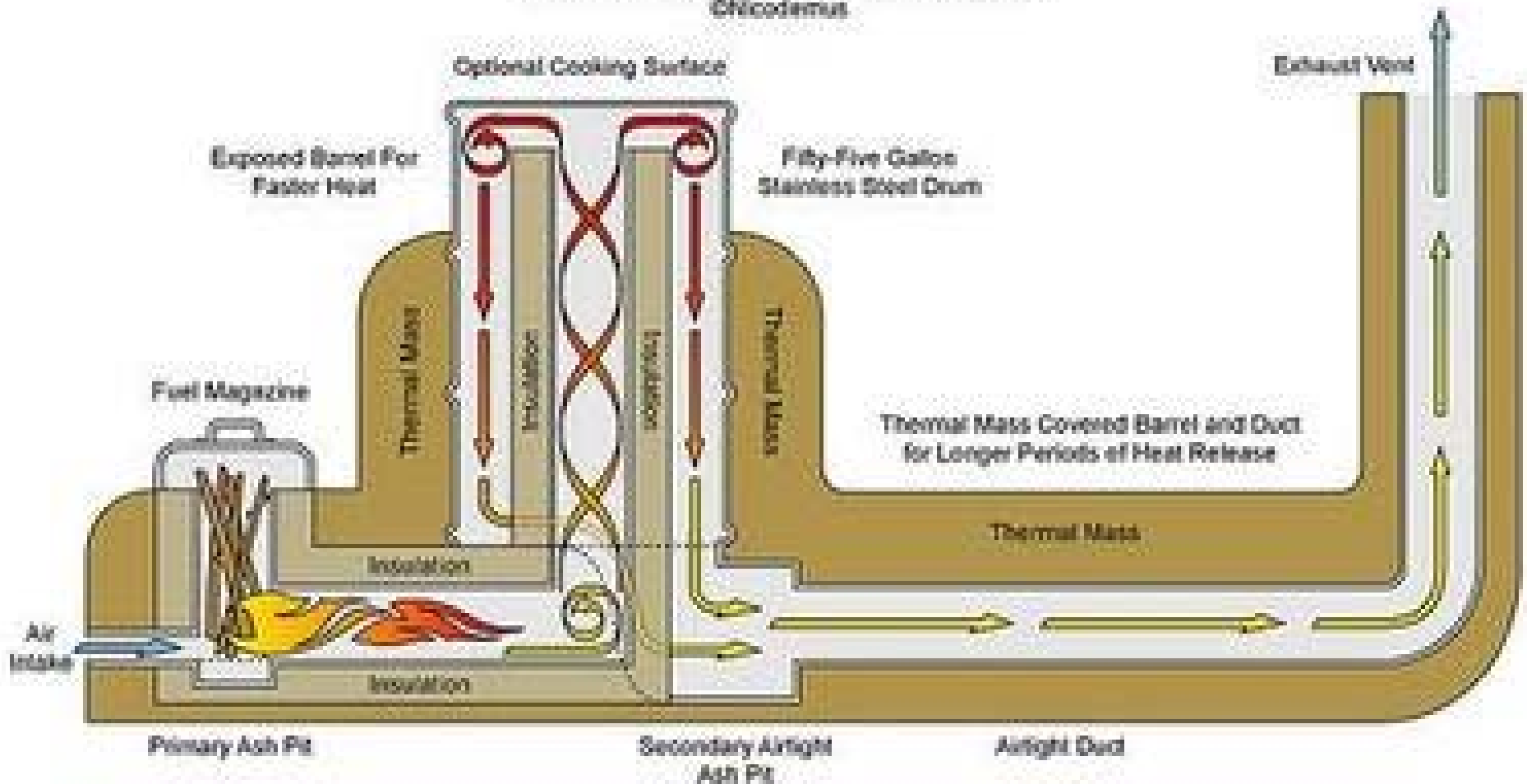
- Unit Heater
- Central Heat
- Radiant Heat
- Solar Heat





Rocket Stove Mass Heater

CHicodemus

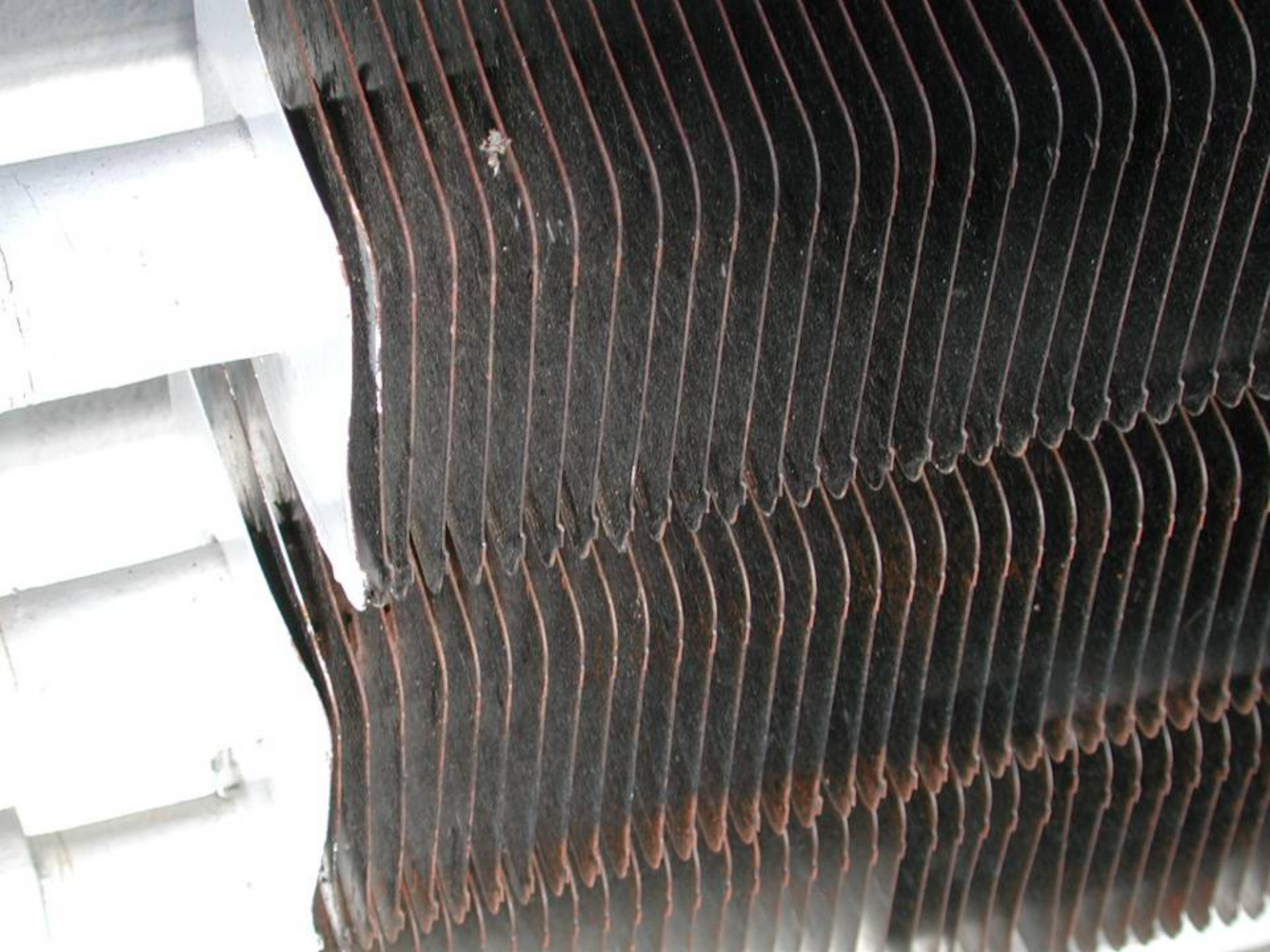












Radiant Heat Systems

- Place above plants in lines running along the length of the greenhouse
 - Can be spaced as far as 40 ft apart
- Composition of reflector is important



Infrared heat tube installation in eaves of greenhouse for maximum heat distribution.

Solar Heat











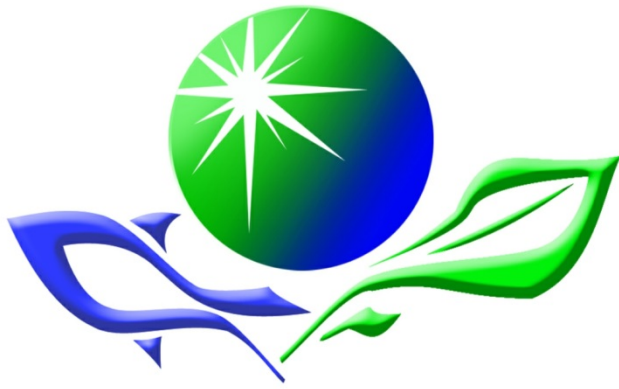












MORNINGSTAR
FISHERMEN
AQUAPONIC RESEARCH & TRAINING

QUESTIONS??

“The world steps aside for a man
who knows where he is going”

Emerson